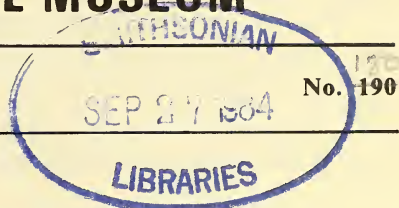


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HABITS AND BREEDING BIOLOGY OF THE GREAT BLUE TURACO *CORYTHAEOLA CRISTATA*

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ABSTRACT

The purpose of the study was to discover, without disturbing natural behaviour, as much as possible about the habits, breeding biology and food sources of the Great Blue Turaco *Corythaeola cristata*, the largest of the turacos *Musophagidae*. Direct observation in the field was the main study method, and the results were summarised after five years of fieldwork. The author concluded that colour ringing of some adults and juveniles would greatly aid further studies on population estimates, the development of juveniles to adults and possible group feeding of the young.

INTRODUCTION

Despite their relatively large numbers and brilliant plumage, only two species of the genus *Tauraco* have been studied in the wild, namely Hartlaub's Turaco *T. hartlaubi* (Van Someren 1956) and the Knysna Lourie *T. corythaix* (Courtenay-Latimer 1942; Stannard 1971).

Species that have been studied in captivity include the Knysna Lourie and the Purple-crested Lourie *T. porphyreolophus* (Jarvis & Currie 1979), the Grey Turaco *Corythaixoides concolor* (Roles 1970), and a recently published account of Great Blue Turacos in the Berlin Zoo (Reinhard & Blaszkiewicz 1981).

In May 1976, G.R. Cunningham van Someren of the National Museums of Kenya, Nairobi, requested information on the nesting of the Great Blue Turaco in and around my garden at Kaimosi, South Nandi in western Kenya (34°56' E – 0° 10' N; altitude c. 1780 m), on the eastern extremity of the species' range (Snow 1978). This study was initiated in the October of that year, utilising a scheme of study compiled by the late L.H. Brown.

STUDY AREA AND METHODS

The main study area comprises both artificial and natural habitats. The former consists of a house and garden with exotic tree species set in tea *Camellia sinensis* and avocado *Persea americana* plantations, while the latter are stream valleys which were previously part of the Kaimosi forest. The whole area is close to the Kakamega forest, where the Great Blue Turaco also occurs.

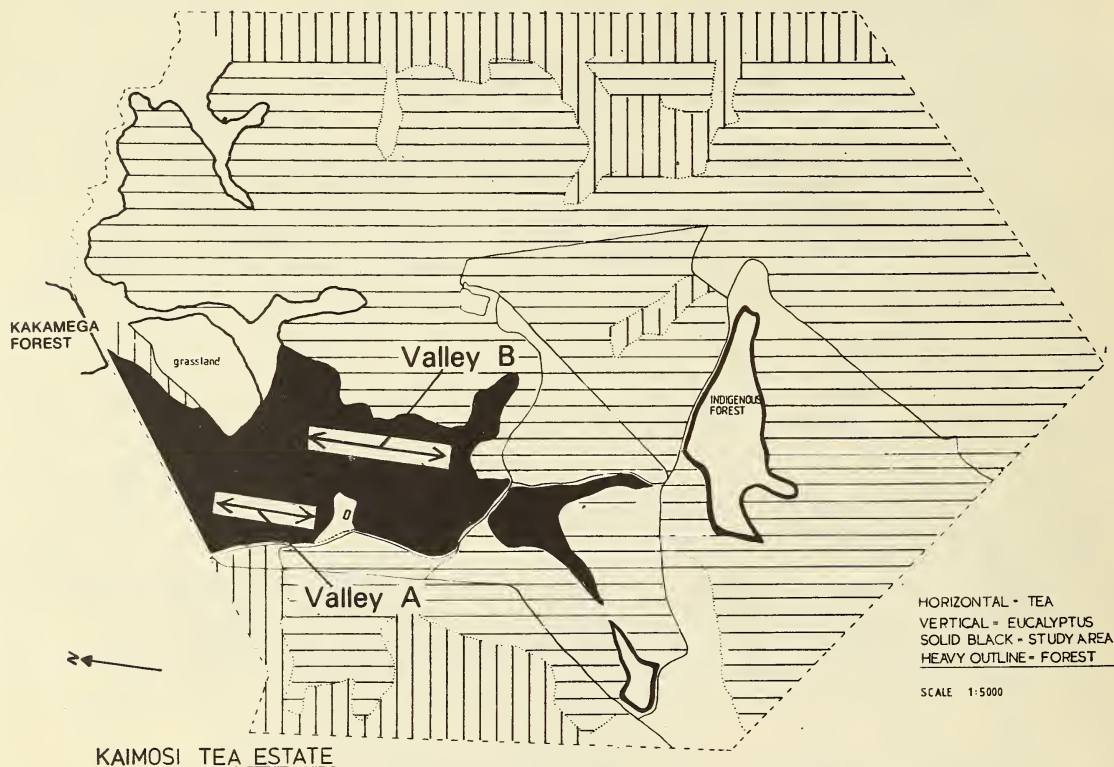
Following Dr. Brown's study scheme, the methods of observation consisted of direct observation by the author, with the aid of house and garden staff when necessary. Attempts were made to spread observations throughout the day and, on specific days, dawn to dusk observation was maintained. When possible, the birds were followed on foot. During 1977/78 a ladder was put up into one of the main nesting trees, and a long aluminium pole with a mirror attached was used to see into the nest. No birds were ringed or tagged for fear of disturbing their natural behaviour. With regard to the identification of food sources, photographs were taken when possible and, when attempts at identification from Dale and Greenway (1961), Eggeling (1940), and Greenway (1940) proved unsuccessful, specimens were gathered, dried and taken to The Herbarium, Nairobi, for identification. Some tape recordings were made of the various calls.

GENERAL BIOLOGY

Group size

Within the study area the Great Blues move in groups which vary in size from six to eighteen. They are gregarious, pairing off to breed. However, a third bird has often been noted in the vicinity of a nesting pair. Within the study area, the range of this species is estimated to be 2km^2 (covering the areas of Valleys A and B, and extending into the remaining ten hectares of indigenous forest on the estate - Fig. 1). However, this estimate could be inaccurate as, on occasions, they have been seen to cross into the study area from the edge of the main Kakamega forest.

FIGURE 1

**General habits**

Daily activities begin soon after dawn and feeding commences early e.g. at 0700hrs. Later on, as the day warms up, members of a group may preen extensively (when scratching, the indirect method is used) and bask in the morning sun. A large part of the day is spent feeding, with preening and resting intervals, and there is a lull in activity during the hottest period from midday to early afternoon. A group may not necessarily feed on the closest available source of food, but may travel a considerable distance to reach a particular favourite of the moment, i.e. *Bridelia micrantha* fruits in April, Loquat *Eriobotrya japonica* fruits in July, Guavas *Psidium guajava* in September and *Cordia abyssinica* drupes in November and December.

After heavy rainstorms, time is spent 'drying out' with wings and tail spread in the sun. Towards late evening, the birds begin the move to the roost, showing a marked preference for very tall trees. Prolonged and noisy calling by the birds is a striking feature of these journeys.

They are not aggressive birds. However, when called upon to defend a nest site, or protect juveniles, they will do so stoically, and they are very attentive parents.

For example, while building nests, pairs are frequently attacked by a pair of Ross's turacos *Musophaga rossae* which generally nest in the garden at approximately the same time. Fighting between the two species occurred on numerous occasions, and this was almost always initiated by the Ross's. The Blues were successful in defending their nest sites and were never seen to attack a pair of Ross's while the latter were building. The fighting took the form of noisy chases within the nesting tree, with the attackers eventually being routed. Often, more than one attack would take place during a building session. When both species were feeding in the same tree, either might dominate.

The Ross's were also unwelcome visitors to nestlings and fledglings, but were chased away apart from on one occasion, when both species nested in the same tree at the same time, but at different stages. On this occasion, an incubating Ross's pair attacked two newly-fledged Blues, driving them out of the tree in different directions, despite the defensive attempts by the accompanying parent.

Noticeable intra-family aggression in the Blues has been lacking, as has serious friction between group members.

Voice

The main call is a loud, raucous and resonant *kok. kok. kok* which sometimes begins and usually ends with a softer, plaintive (trill-like) *prru. prru*. This is the call heard at dawn and dusk, and is a notable feature of the area. When the first bird calls, others in the locality take up the call. The earliest call recorded during the study was at 0550hrs (November), the latest at 1915hrs (February). The main call is also used throughout the day, and from the nest at breeding times. The *prru. prru.* part of the call is sometimes used on its own. Both male and female make similar calls. When greatly alarmed, the birds utter a very harsh and penetrating version of the main *kok. kok* call. If resting or feeding in a tree, and suddenly disturbed (but not sufficiently to cause flight) a soft warning *caw* can be heard, probably a variation of the *prru.* call.

As they build, or pass through the trees, they make a soft whistle type of sound, described in my field notes as *mew. phew. mew. phew*. This is an almost continuous sound, and often indicates the whereabouts of a pair or group before an actual sighting. Towards the end of nest building sessions, a soft *chook. chook*, made by one of the pair and becoming louder just before leaving the nesting tree, was most probably a departure signal to the mate. This same *chook. chook* was heard when newly-fledged juveniles were being encouraged to gain height within a tree, and when the adult called the fledglings to move to the roost. This same sound was also heard from a group which had paused in the garden before flying on to another area.

They have a system of contact calls, utilising the main call already described, designed to locate a mate, family or feeding group. Calls were frequently heard from the nest, mostly in the evenings, and a lone call could sometimes be heard from the valley near to the house a short while before a change-over at the nest.

The nestling call was a croaky trill, not dissimilar to the *prru. prru.* of the adult, and was made by an eighteen-day-old nestling which had fallen out of a Fig tree in the garden.

Flight

The Great Blue is a poor flier, but can cover distances of up to 200 m at one stretch. This poor flight performance is probably a reflection of the fact that the birds naturally inhabit dense forest with small distances between perches. Just prior to flight they will bob their heads and, quickly and briefly, fan their wings and tails simultaneously. They launch themselves off from the tops of trees, having run assuredly along and up branches to reach this position. This ability to hop and run confidently in trees is a characteristic of the *Musophagidae*.

The flight consists of two or three flaps followed by a long glide. They tend to lose height with distance, often, after longer flights, landing a metre or so above ground in a tree or bush.

When travelling from one area to another, members of a group follow one another at regular intervals, occasionally pausing to re-group. They then fly on to the next clump of trees one at a time. Only once were five birds seen to fly off at the same time.

Within the study area, the birds are frequently seen crossing the two sections of tea plantation in front of the house, skimming low over the bushes. During flight, the almost continuous soft whistling sound referred to earlier can be heard.

Food and feeding

Feeding sources are listed in Table 1 together with tree and plant species so far identified within the study area.

TABLE 1

*Tree and plant species identified to date
within study area*

(F) denotes feeding source

<i>Acacia abyssinica</i> Hochst.	<i>Mimosaceae</i>	(F)
<i>Albizia gummifera</i> (J.F. Gmel.) C.A. SM.	<i>Mimosaceae</i>	
<i>Antiaris toxicaria</i> (Pers.) Lesch	<i>Moraceae</i>	(F)
<i>Bersama abyssinica</i> Fres.		
subsp. <i>abyssinica</i>	<i>Melianthaceae</i>	(F)
<i>Blighia unijugata</i> Bak.	<i>Sapindaceae</i>	
<i>Bridelia micrantha</i> (Hochst.) Baill.	<i>Euphorbiaceae</i>	(F)
<i>Celtis durandii</i> Engel.	<i>Ulmaceae</i>	(F)
<i>Chaetacme aristata</i> Planch	<i>Ulmaceae</i>	(F)
<i>Cordia abyssinica</i> R. Br.	<i>Boraginaceae</i>	(F)
<i>Croton macrostachyus</i> Hochst. ex. Del	<i>Euphorbiaceae</i>	
<i>Dracaena steudneri</i> Engl.	<i>Agavaceae</i>	(F)
<i>Eriobotrya japonica</i> (Exotic - loquat)	<i>Rosaceae</i>	(F)
<i>Fagaropsis angolensis</i> (Engl.) Dale	<i>Rutaceae</i>	(F)
<i>Ficus capensis</i> Thunb.	<i>Moraceae</i>	(F)
<i>Ficus quibeba</i> Ficalho	<i>Moraceae</i>	(F)
<i>Ficus thonningii</i> Blume	<i>Moraceae</i>	(F)
<i>Gouania longispicata</i> Engl.	<i>Rhamnaceae</i>	(F)
<i>Manilkara butugi</i> Chiov.	<i>Sapotaceae</i>	(F)
<i>Markhamia platycalyx</i> Sprague	<i>Bignoniaceae</i>	(F)
<i>Neoboutonia macrocalyx</i> Pax	<i>Euphorbiaceae</i>	
<i>Olea welwitschii</i> (knobl.) Gilg. & S. Schellenb.	<i>Oleaceae</i>	(F)
<i>Phragmanthera rufescens</i> (DC) S. Balle	<i>Loranthaceae</i>	
<i>Polyscias kikuyuensis</i> Summerhayes	<i>Araliaceae</i>	
<i>Prunus africana</i> (Hook.f.) Kalm	<i>Rosaceae</i>	
<i>Psidium guajava</i> L. (Exotic - guava)	<i>Myrtaceae</i>	(F)
<i>Sapium ellipticum</i> (Krauss) Pax	<i>Euphorbiaceae</i>	
<i>Schefflera abyssinica</i> (A. Rich.) Harms	<i>Araliaceae</i>	(F)
<i>Syzgium guieense</i> (Willd.) DC	<i>Myrtaceae</i>	(F)
<i>Zanthoxylum gillettii</i> (De Wild.) Waterm.	<i>Rutaceae</i>	

Blues are frugivorous, but buds, shoots, leaves and flowers are included in the diet (see Table 2 for analysis of plant parts). Leaf-eating occurs throughout the day but is particularly pronounced last thing in the evening. Regurgitated leaves are fed to nestlings from eight days on (and possibly earlier). The birds were not seen to drink water (see Points Requiring Further Study) or eat insects.

Only two of the food sources listed are exotics, namely the loquat and the guava. Both of these are extremely popular, and are consumed in large quantities when available. The birds can be seen visiting trees of both these types to test the fruits before they ripen, and guavas are sometimes eaten when still quite green and hard. Only the smaller guavas are swallowed whole, the larger ones being consumed in stages. Loquats are frequently swallowed whole, on occasion with some

difficulty. A small guava measures approximately 16 x 120 mm, a loquat 52 x 99 mm. Figs *Ficus capensis* measuring 18 x 38 mm are eaten whole. By contrast, *Cordia abyssinica* drupes measure 16 x 35 mm and receptacles of the *Ficus thonningii* only 12 x 30 mm, illustrating that the size of fruit taken varies considerably (see Table 2 for fruit size).

TABLE 2

*Analysis and size of plant parts**

(Specific names as in Table 1)

TREE	LEAF	FRUIT	SIZE	COLOUR
<i>Acacia</i>	Pod		62 - 100 x 12	Green, brown when dry
<i>Antiaris</i>		Fruit, drupaceous, ellipsoid	18 length	Red and velvety when ripe
<i>Bersama</i>	Buds, leaflets		203 x 50	
<i>Bridelia</i>		Drupe, ellipsoid	6 - 8 length	Blue/Black
<i>Celtis</i>		Drupe, ovoid	8 length	Yellow
<i>Chaetacme</i>		Drupe, globose	12 diam.	Yellow
<i>Cordia</i>		Drupe, ovoid	16 x 35	Yellow
<i>Dracaena</i>		Berry	13 - 14 diam.	Dark brown/ black
<i>Eriobotrya</i>		Fruit	52 x 99 circum.	Yellow
<i>Fagaropsis</i>		Fruit, globose	7 x 14 diam.	
<i>Ficus cap.</i>		Fig, glabrous	18 x 38	Yellow/red
<i>Ficus quib.</i>		Receptacles, paired - globose	17 diam.	Yellow
<i>Ficus th.</i>		Sessile receptacles, globose	12 x 30	Green/yellow
<i>Gouania</i>		3-winged capsule	12 length	Green/yellow

TABLE 2 (Cont.)

TREE	LEAF	FRUIT	SIZE	COLOUR
<i>Manilkara</i>		Fruit	25 length	Yellow
<i>Markhamia</i>	Flower			Yellow, striped and spotted with red in axillary and terminal panicles
<i>Olea</i>		Drupe, ellipsoid	8 length	Green/yellow
<i>Psidium</i>		Fruit	16 x 120 circ.	Green/yellow
<i>Schefflera</i>		Fruit	6 - 8 length	Red
<i>Syzygium</i>		Fruit ovoid	12-25 length	Purple/black

* All measurements in mm

When the loquats or guavas in the garden are ripe, groups fly into these trees to feed on and off throughout the day, returning to the nearby forest of valley A between these numerous feeding periods. The food source closest to hand is not necessarily utilised: a pair nesting in *F. thonningii* were seen to ignore its ripe receptacles in favour of a different food, and receptacles of this species are only ever eaten in small quantities.

On a typical day when food sources were plentiful, a group of eight birds fed on *Olea welwitschii* drupes between 0840 - 1645hrs, and the day's consumption was supplemented with *Markhamia platycalyx* flowers and unidentified leaves. Despite their size, Blues are able to reach fruits at the end of very slim branches by means of their semi-zygodactyl toes, and they have been observed briefly hanging upside down in order to reach particular fruits or berries.

At present, food sources appear adequate in the study area but, with a diminishing habitat, there is increased competition from other fruit-eating birds such as the Black and White-casqued Hornbill *Bycanistes subcylindricus*, bulbuls and greenbulbs *Pycnonotidae*, the Green Pigeon *Treron australis*, barbets *Capitonidae*, and Speckled Mousebirds *Colius striatus*, to name a few. Blues are often chased out of their feeding trees by numerous Red-tailed Monkeys *Cercopithecus ascanius schmidtii*, which are present in the same habitat at Kaimosi.

Feeding may continue until quite late in the evening, members of a group pausing briefly for this purpose during the passage to the roost. During the dry season (January - March), birds feed as late as 1915hrs, when dusk falls.

Table 3 shows the general feeding pattern year by year.

TABLE 3
General feeding pattern October 1976 – December 1980

	1976	1977	1978	1979	1980
J				sy	
F					
M					b
A			b		b
M					
J		ft g	fc	l sc	l
J		a g	d fc l	ft g l	l
A			g l	a ft g l m	g l sy
S		ft m o	g		g
O		g o	c	c g sy	g
N	c	c	c	c g sy	c ft g
D	c g	c ft g	c	c	c

KEY

a = Acacia
b = Bridelia
c = Cordia
d = Dracaena
fc = *F. capensis*
ft = *F. thonningii*
g = Guava
l = Loquat
m = Markhamia
o = Olea
sc = *Schefflera*
sy = *Syzygium*

BREEDING BIOLOGY

The breeding biology will be described in five sections:

1. Courtship and Copulation
2. Nest building
3. Eggs and Incubation
4. Nestlings
5. Fledglings – including breeding success and the post-fledgling stage.

Kaimosi falls within Brown & Britton's (1980) climatic region B, where the main rains occur between March and November, together with sub-peaks during April and May and, at Kaimosi, during August: shorter rains occur during October and November (see Table 4).

TABLE 4
Rainfall figures for Kaimosi 1976-1981*

	1976	1977	1978	1979	1980	1981
J	36.3	114.2	111.3	104.2	61.3	43.1
F	46.7	155.6	240.2	271.5	56.0	101.2
M	51.7	81.4	159.5	168.2	83.1	269.0
A	352.7	332.2	314.6	253.1	378.9	333.7
M	357.7	358.0	206.0	191.5	307.1	149.2
J	166.2	178.5	204.6	271.9	110.9	176.4
J	248.6	186.5	146.2	148.6	196.8	179.2
A	383.1	302.3	164.9	399.3	203.2	149.9
S	183.1	200.4	207.9	153.7	152.7	235.6
O	98.5	227.8	339.7	84.2	169.7	186.2
N	178.5	217.6	78.9	170.6	88.3	112.1
D	22.8	130.9	167.1	70.8	39.1	38.2
Total	2125.9	2485.4	2340.9	2287.6	1847.1	1973.8

* All measurements in mm

Brown & Britton's (1980) summary of East African nest records for the Great Blue Turaco mentions "widespread breeding with 11 out of 20 records in dry months and another four in a break in the main rains. Recent data (M. Candy, unpub.) indicate repeated breeding following nest-failure or rearing a brood.

Region B. 1,2; II,2; III,4; IV,1; V,1; VI,2;
VII,2; IX,3; XI,2; XII,1 = 20".

Each pair seen *building* within the study area was given a number, commencing with GB¹ in November 1976 (GB to distinguish between Great Blue and Ross's Turaco pairs: a study of the Ross's Turaco was started at the same time). Following Brown & Britton (1980) a definite breeding attempt was defined by the laying of an egg. Of the 21 pairs numbered during the study, 18 made definite attempts to breed. Without individual identification, it has not been possible to state how many of these were repeat attempts. These attempts are shown month by month.

I,3; II,1; VII,1; VIII,1; IX,1;
X,2; XI, 5; XII,4 = 18.

The September record refers to pair 8 and derives from an estimate of the dates of incubation and hatching which were unknown.

Chart 1 totals only definite breeding attempts, thus accounting for the discrepancy between the total number of pairs (21) and the number of breeding attempts (18), and shows the success or failure of these attempts.

Van Someren (1956) observed three pairs of Hartlaub's Turacos which were resident in his sanctuary and adjoining woods for five years. He located six nests, four between April and July,

and two between September and January, but gives no further details of dates.

For captive Knysna Louries, Jarvis & Currie (1979) recorded breeding predominantly September to February (but do not state whether this coincided with wet or dry seasons). Other unsuccessful attempts were recorded in June (one), July (two) and August (one).

CHART 1

MONTHLY BREAKDOWN OF SUCCESS OR FAILURE OF BREEDING ATTEMPTS OCTOBER 1976-MARCH 1981											
	0	1	2	3	4	5	6	7	8	9	10
J	1981 GB21 S	1979 GB5 F	1977 GB3 S								
F		1980 GB18 F									
M											
A											
M											
J											
J	1980 GB11 F										
A	1980 GB12 S										
S	1979 GB9 S										
O	1980 GB14 S	1977 GB4 S									
N	1976 GB1 F	1979 GB10 F	1979 GB6 S	1979 GB7 F	1980 GB15 F						
D	1979 GB10 F	1980 GB16 F	1980 GB17 F	1980 GB19 S	1980 GB15 F						
1976 = 2 1978 = 0 1980 = 8. YEARLY TOTALS.											
1977 = 2 1979 = 5 1981 = 1, UP TO MARCH											

S = SUCCESSFUL F = FAILURE E = ESTIMATE OF BREEDING MONTH

Courtship and copulation

Courtship is a simple and straightforward ceremony where the male first feeds the female, then mounts. Van Someren (1956) observed a male Hartlaub's Turaco feed his mate prior to mating, and Roles (1970) noted mutual courtship feeding by Grey Turacos.

Courtship was observed on four occasions: 8 December 1976, 7 October 1977, 23 September 1978, and 25 January 1979. The first occasion was marked by considerable noisy calling and flying activity by other birds in the immediate vicinity, and by the presence of a third bird which was chased away whenever it approached the pair. After mating, the pair spent a brief period perched apart, then moved back closer to each other and touched beaks, but mating was not repeated.

On the second occasion that a third bird was present, it was not chased away. After mating the male ruffled its feathers, perched a short distance away from the female and a third bird rejoined them, having earlier been feeding with the pair. The male then began to preen and the female scratched her head and also began to preen. The only feature distinguishing male and female was that the former appeared slightly larger in size. All three preened, then later flew out to feed in a nearby *O. welwitschii* tree.

On the third occasion, a group of five were seen to fly across the garden to the forest, and here two of the group mated while the others were feeding fairly close by. On the fourth occasion only a pair was present.

Nest building

During the months of April, May and early June, Blues are not seen regularly in the garden. However, they return once the loquats begin to ripen and from July onwards pairs will visit, prospecting for suitable nest sites. On occasion, a pair may be accompanied by a third bird.

The sites chosen vary in height from 10.66 to 16.05 m and may be hidden in a clump of semi-parasitic Mistletoe *Phragmanthera rufescens* (the bole of the Mistletoe sometimes being used as a platform base for the nest), or in a creeper-covered tree.

One site in a Fig was at a height of 16.02 m and was regularly chosen. The dense foliage of this Fig provided good cover and pairs using this site were the most successful (six out of eight), while pairs utilising the exposed site in the large *Jacaranda acutifolia* just outside the garden were the least successful (zero out of five). Of the four pairs which nested outside the garden, two were successful, one in a densely creeper-covered tree in the forest just beyond the garden hedge and the other in a *Blighia unijugata* in the avocado plantation. It would therefore seem likely that the garden provided extra protection.

During the initial prospecting stage, if an old site is being used, the pair spend time lying in the old nest. Sometimes they may lie side by side in the nest, but more often one of the pair lies in the nest for over ten minutes with the mate perched nearby. The one in the nest shakes its head, arches its neck, half opens its beak and arches its neck again. It also turns its head from side to side while continuing to open and close its beak. These movements are repeated several times. It may nibble at the foliage and twigs nearby, and, if the mate is sufficiently close, nibble the mate's crest and chest. The one lying in the nest then hops out, and the mate may take its place, making similar head and neck movements. These actions are more marked by one of the pair. These displays occur when an old nest is being used or when a new nest is sufficiently advanced.

Building begins once a site has been chosen and activity is concentrated mostly in the mornings, pairs generally arriving at the tree between 0800hrs and 0900hrs, or exceptionally by 0700hrs. The Knysna Louries studied by Stannard (1971) appeared to be most active in the mornings but, on occasions, continued to build until 1400hrs or 1430hrs. If a Blue pair is accompanied by a third bird, this other bird may wait elsewhere in the garden or, after a short while, fly on to the forest or return to the valleys. A third bird has never been seen to help build.

Both sexes collect twigs and, while one appears to do more of the actual arranging of twigs in the nest, collecting is shared more or less evenly. During building, they are not disturbed by close human presence and will continue to collect even as people walk right under the tree. Nor are they diverted by noisy car or tractor arrivals and departures nearby. Short feeding breaks are taken. The duration of building varies from five to thirteen days, but six to nine would be about

average. The end of a building session is heralded by fairly strong *chook*. . *chook* sounds from one of the pair.

The nests are constructed from dead twigs (Table 5) beginning with long heavy ones (e.g. 610 mm long by visual estimate). These longer twigs can present difficulties, the bird concerned having to pull and drag them up to the nest. The builders are selective, often breaking off two or three twigs and dropping them before making a final choice. As stated before, mistletoe boles, or the fork of a wide branch, may be used as a platform for the nest. A nest at 16.02 m in a Fig measured 508 x 305 mm. Mackworth-Praed & Grant (1957) describe the nest as appearing ridiculously small for the bird when sitting. Old nests are often repaired and used again. On completion some nests look flimsy and insecure, others well constructed. Nests have a shallow rim, and the interior of one nest had been lined with slim Bottlebrush *Callistemon speciosus* twigs.

TABLE 5
Counts of twigs taken to a nest under construction by pair 4

5 October 1977		
0820 - 1050hr	50	(36 <i>Cordia</i> , 14 <i>F.th.</i>)
1230 - 1300hrs	5	4 <i>Cordia</i> , 1 <i>F.th.</i>)
6 October 1977		
0710 - 1010hrs		
and		
1025 - 1115hrs	57	(49 <i>Cordia</i> , 7 <i>F.th.</i> 1 <i>Grevillea robusta</i>)
7 October 1977		
0810 - 1005hrs	32	(23 <i>Cordia</i> , 7 <i>F.th.</i> 2 <i>Callistemon</i>)

Friction between Blues and Ross's at breeding times has been described under General Habits.

Eggs and incubation

The eggs, which are laid in clutches of one, two or three, are almost spherical and pale glaucous-green (Ridgeway 1912). A fresh egg measured 46 x 41 mm and weighed 38 g. Mackworth-Praed & Grant (1957) describe this species' eggs as approximately 50 x 43 mm. Fresh eggs of Ross's Turaco (two samples; pers.obs.) measured 40 x 40 mm and 39 x 39 mm respectively. Britton & Britton (1976) mention egg shape as variable in the *Musophagidae*, and quote dimensions of 36.1 x 34.6 mm for Fischer's Turaco *T. fischeri*, 36 x 33 mm for the Guinea Turaco *T. persa*, 40 x 34 mm for Livingstone's Turaco *T. livingstonii*, and 38 x 32 mm for the Knysna Lourie.

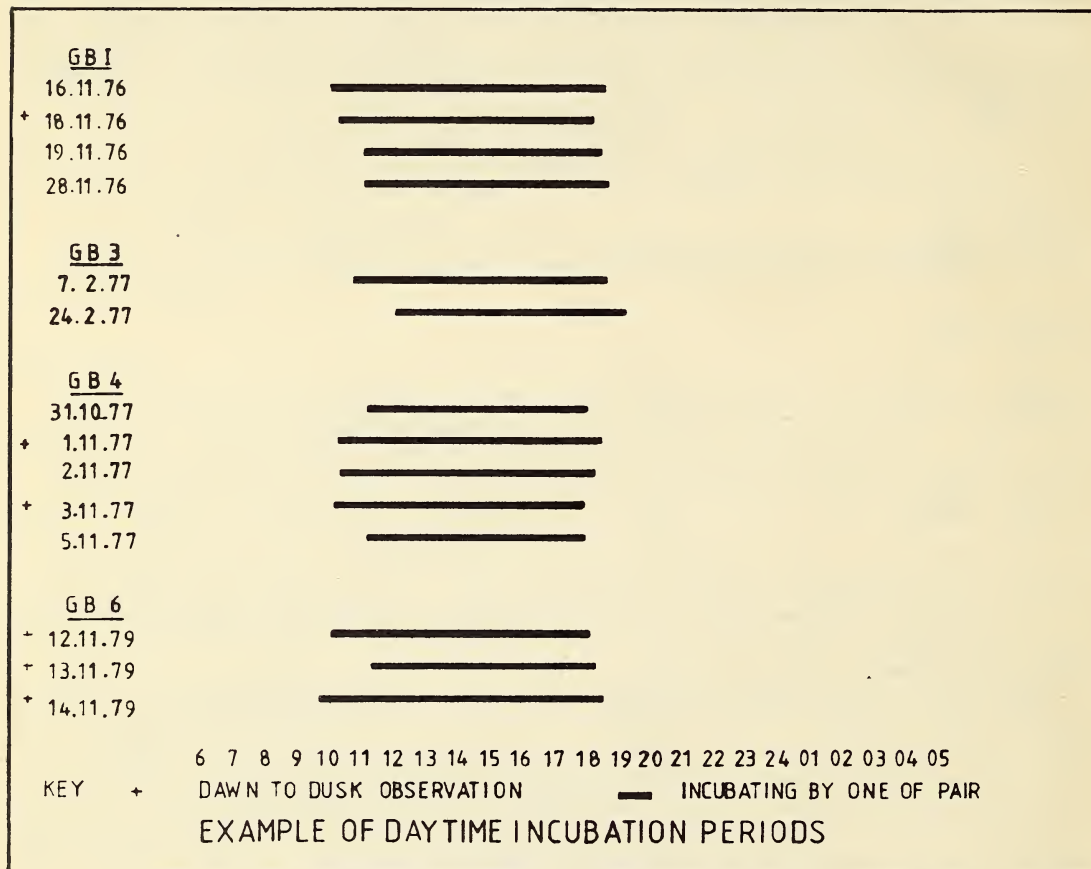
In some cases the Blue's first egg is laid on the same day that building ends, in others, there is a gap of 24 hours. The eggs are laid on successive days, the first egg in the late afternoon or evening, the second egg the following morning. Incubation is continuous once the clutch is complete.

The female is accompanied by her mate, who perches nearby while she lays the first egg and, on one occasion, while the second egg was laid the following morning.

During day one of incubation by pair 4, the author climbed the ladder into the Fig but the incubating bird showed hardly any reaction. The author was curious to see whether the bird could easily be persuaded to move off the eggs, and poked it several times with the long aluminium pole in an attempt to see into the nest. These attempts were unsuccessful. However, on a later date, it proved possible to see into the nest by climbing the ladder and intercepting the pair just as one clambered off the nest and the other waited in the tree. It was unusual for a bird to move off the nest until the mate was close by, and this afforded an excellent opportunity to see into the nest and verify the clutch number (which was two in this case).

Both sexes share in incubation. Two to three change-overs take place during the first day, settling into a pattern of morning and evening changes. During dawn to dusk watches on three different pairs (1, 4 and 6), the morning change-over took place between 0945hrs and 1115hrs and the evening between 1750hrs and 1830hrs. From these watches it was observed that one of a pair may incubate during the day for a period between 6 hours 56 minutes and 8 hours and 40 minutes (Chart 2 gives examples of daytime incubation periods).

CHART 2



When a bird is arriving for a change-over, if hot and panting, the gular flutter is very noticeable. They approach the nest silently, sometimes, but not always, bearing a twig, or the incomer may break off a twig from within the nesting tree and carry it up to the nest. As stated above, the incubating bird seldom moves off the eggs until the mate has reached the nest. Feeding of one mate by another at the nest and during incubation was not seen.

After the change-over, the outgoing bird may fly a short distance away, then perch, stretch its legs several times, preen and then fly off, bobbing its head and fanning its wings and tail before doing so. Sometimes they call loudly as they depart and, if flying down to valley B, call on the long glide down to this area.

Daytime and evening (particularly late evening) calls were frequently heard from the nest, and on these occasions both parts of the main call were used, but not necessarily together. The *prru* part of the main call was more often used on its own in the evenings.

It has not been possible to establish satisfactorily which sex incubates at night; Roles (1970) states that it was the female of the Grey Turaco which usually brooded overnight. Only two pairs

had discernible individual differences, and their sexes were not known.

Incubation takes 29 to 31 days, compared to 16 to 18 days for Hartlaub's Turaco (Van Someren 1956), 24 to 26 days for Ross's Turacos (pers. obs.), 23 or 24 days for Knysna Louries (Stannard 1971), and 28 days for Grey Turacos (Roles 1970).

Nests are subject to attacks by raptors such as African Goshawks *Accipiter tachiro* and Blue monkeys *Cercopithecus mitis*, and snakes such as the Forest Cobra *Naja melanoleuca*.

Reactions to Human Presence

There was not a marked reaction to close human presence at the nest but there were some differences in individual behaviour. The reaction might take the form of slight wing spreading and crest ruffling, opening the beak and wing spreading, or tail raising. On one occasion there was no reaction at all, the incubating bird seeming more intent on listening to sounds below the tree. However, when a group of Vieillot's Weavers *Ploceus nigerrimus* flew into the Fig and landed near the nest, the incubating bird rose up fully erect on the nest (it did not fly up) and opened its beak very wide in a threatening attitude.

This tolerance of human presence did not extend to change-overs; an incoming bird could remain motionless for up to fifteen minutes until the observer backed down the ladder and left the tree. On one such occasion, the incoming bird flew back out of the Fig to a nearby *Cordia*, having uttered a *caw* of alarm at finding the observer on the ladder, and waited here for two hours before returning to the nest, despite the fact that the observer had moved completely away from the tree. After this, the author was careful to avoid being on the ladder at change-over times.

There was a difference between the attitudes of one pair to human presence while feeding nestlings. One parent showed no hostile reaction and continued to regurgitate food but, again just after a change-over, the newly-arrived parent refused to feed the nestlings while the observer was close and waited until she had retreated a considerable way down the ladder.

A nestling once spread its wings at the observer's approach.

Nestlings

At birth, the young are covered in dark brown neossoptile down. The eyes are slightly open, while the beak is pale cream with a dark tip.

Both parents feed them, taking it in turns to do so (on no occasion were both parents seen simultaneously at the nest). The first feed takes place soon after dawn and, during the first week, nestlings receive up to six feeds per day, increasing to eight or nine; by the 28th day they are receiving eleven or twelve (see Table 6).

At feeding times, the parent approaches the nest silently and cautiously. Chicks are fed regurgitated fruit and leaves, the food passing directly from the parent's bill into that of the chick. Leaves were first seen in the diet of nestlings eight days after hatching.

The size of food taken by nestlings varied. On one occasion, the parent feeding the nestlings was seen to regurgitate nearly a whole guava (a small one measures approximately 16 x 120 mm) from which the two nestlings attempted to pull off pieces. They found this impossible, and the parent had to regurgitate the fruit three times before the pieces were of a suitable size. Even so, one nestling swallowed a piece almost large enough to cause choking.

In general, nestlings were fed for three to four minutes at each feed, though durations of two minutes and five to six minutes were also noted. Quite frequently, at the end of a feed, a nestling would continue to pull and tug at the parent's beak, and bill its flank and breast. If, as seems likely, this was begging, the request was rarely granted.

Nestlings are fed in the nest for most of the time, but one was seen being fed at the edge of the nest at eighteen days. Two others moved out of the nest to meet the incoming parent but hopped back into the nest for the actual feed.

Some time after a feed, when the nestlings are newly-hatched, and for a further three weeks or so, the parent bills the anus of the nestling, as in Hartlaub's Turaco (Van Someren 1956). The nestling then raises its tail and the voided excreta is consumed by the parent. Later on, the nestlings simply raise their tails and present the anus to the parent, which consumes the excreta.

General noises do not appear to upset the nestlings, but unusually loud sounds, in particular,

TABLE 6
Examples of nestling feeding times and totals

NESTLING AGE IN DAYS	PAIR NUMBER	DATE	FEEDING TIMES	TOTAL FEEDS
5	4	14.11.77*	0631 hrs 0731 hrs 1022 hrs 1320 hrs 1520 hrs 1735 hrs	6
16	4	25.11.77*	0645 hrs 0837 hrs 1030 hrs 1115 hrs 1225 hrs 1459 hrs 1605 hrs 1805 hrs	8
27	12	17.10.80*	0635 hrs 0740 hrs 0803 hrs 0918 hrs 1010 hrs 1110 hrs 1217 hrs 1419 hrs 1510 hrs 1615 hrs 1743 hrs 1825 hrs	12

* Dawn to dusk observation.

the banging of a tractor and trailer passing noisily on the road behind the garden, cause considerable fright. The parent becomes very still, raises its crest and listens intently; and the nestlings, if outside the nest, return quickly and nestle still and close to the parent.

The nestlings are active in the early mornings, and, depending on their stage of development, spend short periods outside the nest where they perch and preen and hop about, and move in and out of the nest. When back in the nest they pull and tug at foliage and twigs nearby. When hot during the midday hours, they lie in the nest, panting with gular flutter and dozing on and off, and becoming more active again in the late afternoon and evening.

Between sixteen to eighteen days, the nestlings move energetically around in the nest, and this is the age at which the nestlings of two different pairs were first observed at the nest's edge. They venture outside the nest for extended periods from 24 days on, and climb and perch above the nest at 27 days and from this age until approximately 33 days, begin flying about in the tree.

During the nest period of one nestling (pair 3), one parent was always in attendance, day and night. Other nestlings were first seen alone briefly at 27 days and 29 days respectively, but were always accompanied at night; still others were left alone twice in one day at 27 days.

Prior to leaving the nesting tree, short flights are made within the tree, and from one side to the other. The age at which they leave varies from 31 to 35 days (Table 7). At this stage, the wings and tail of the fledglings have adult blue colouring, and the wings look large in proportion

to the rest of the body. The head is small, bare, flat on top and ridged in the centre, with no crest development. The beak of one nestling had a quite definite groove in it at this stage.

TABLE 7
Departure dates for various nestlings

PAIR NUMBER	AGE IN DAYS AT DEPARTURE
3	31 (possibly slightly early following raptor attack on nest)
4	35
6	38
12	34
14	33

Fledglings

The departure from the nesting tree takes place before fledglings can fly any great distance, and consequently they often land on the ground after their first flight. Of two fledglings, one successfully flew from a Fig to a *Cordia* (14.6 m away), while the other one landed in the undergrowth of a stand of *Grevillea robusta* (18 m away). Fledglings do not seem to injure themselves during this initial landing and, if they land on open ground, they rapidly run and hop to reach cover. Both parents are in close attendance at this time and are in the nesting tree when the fledglings leave. The adults make short flights, a metre or so above ground, backwards and forwards above the fledglings (if the latter are on the ground), to encourage them to move in the required direction. If a fledgling is in undergrowth, one parent will fly low, making *chook* . . . *chook* sounds, and perch above the fledgling. The parent then moves gradually higher, calling and encouraging the fledgling to follow, and rewarding it with food from time to time. The fledgling follows, hopping and struggling up the tree, often perching rather precariously. The regularly-spaced branches of a *Grevillea* are of considerable help at this stage.

If there are two fledglings, one parent will remain with each. At this stage, the fledgling calls to the parent with a croaky trill.

By evening of the first day, a fledgling will have reached the top of a tall tree, and will be accompanied overnight by one parent. On occasion, a fledgling that had been high in a tree the previous evening was found down on the ground again in the early morning, and short periods are spent on the ground by juveniles. During the day, the newly-fledged juveniles are left alone for brief periods only: as the parents come and go to feed them, one parent accompanies the fledglings for most of the time until the other returns. If a fledgling has been left alone and calls, an adult will return to it. During the first two or three days, fledglings remain quiet and fairly still while alone. They are always accompanied at night at this stage; the youngest birds seen alone overnight had an estimated age of 45 days.

A visual estimate of the length of a fledgling at this stage is 250 – 280 mm and the weight of one was 226 g (as compared to 550 g for a captured adult that was possibly in poor physical condition). Fledglings that had bred in a Fig in the garden and attained a stand of *Grevillea* 18 m away remained there for a further six to eight days. The time spent in this stand was a strengthening period, for the fledglings while they gained confidence and improved their flying ability. They were fed up to twelve times a day (the maximum number of feeds per day recorded during the study was fourteen for 40- to 45-day-old fledglings), and left alone with increasing frequency and for periods of up to an hour. From time to time, both parents returned to the stand, often flying in low and then making short flights back and forth several times to a dead tree 73 m away from the stand. The fledglings did not attempt to follow on these occasions, yet did so immediately at feeding times and when following the parent to the roost, which raised the interesting question as to how these fledglings knew when to follow the parent and when to remain where they were.

After two or three days in the stand, they began to move about more in the trees, flying longer distances, and running along branches with increased agility. At an age of 40 days, one

flew low in a graceful arc to meet the incoming parent.

On two occasions, groups of four and three adults were seen to closely approach fledglings, but not more than one of the adults fed the younger birds. However, co-operative feeding cannot be certainly ruled out, as there is a previous unconfirmed observation of this activity (R. Barker pers. comm.).

Four pairs remained with their fledglings in the garden for this strengthening period, while another pair took their brood just outside the perimeter.

When the fledglings are ready to make the journey over to one of the nearby valleys, the procedure is very similar to that observed when fledglings leave the nesting tree. The departure is often preceded by loud *kok*. *kok* calls, and one parent may go ahead to the valley leaving the other to accompany the fledglings.

One brood left the garden when they were 43 days old. Loud *kok*. *kok* calling was heard at 0920hrs, and one parent flew from the stand to the dead tree. The fledglings followed, launching themselves off from the *Grevillea*, but neither was able to reach the parent 73 m away and both landed in an avocado plantation. One fledgling had flown 43 m approximately, the other 21 m. Both hopped and ran across the open ground until they reached the edge of the undergrowth below the dead tree. The parent flew closer and encouraged them to make their way up a small tree until they were approximately three metres above ground. They perched close together, whereupon the parent flew off, returning five minutes later to feed them. The fledglings then successfully flew in short stages deeper into the valley, and became lost to sight.

This stage proved to be the most difficult at which to obtain information on the development of juveniles as none of them certainly returned to the garden. From observations of young in apparently progressive stages of development, however, the following can be described. At a possible age of 66 days a juvenile had five short crest feathers, and the beak had thickened and rounded down, but was still dark. Apart from the wings and tail, the general body appearance was still darkish brown. The tail had grown considerably, much more so than the wings. The legs looked strong and well-developed, and there were rust-coloured feathers around the thighs. The cream marking in the tail could be clearly seen. It must be stressed that the age of 66 days for this juvenile is a very tentative estimate. At a later stage, the bill becomes yellower, changing to bright yellow with a red tip in the sub-adult. At this latter stage it calls like an adult, but it is still being fed by parents.

It has not yet been possible to ascertain how long it takes the juveniles to attain adult plumage or the length of time they remain with the parents. It is possible that the whole family remains together within a group and that a juvenile is fed for some considerable time by the parents.

Inter-nest Relations

During 1979/80, unique incidents were observed between different pairs and fledglings.

One of the fledglings of one pair had suffered setbacks on two occasions when the parents attempted to take it from valley A to valley B, while the other fledgling had made the journey successfully. The first fledgling was thus alone in a large *Jacaranda* at 1850hrs, and it moved down close to where one of another pair was incubating and perched near to the nest. The incubating adult stretched forward, briefly preened one of the fledgling's wings and appeared to feed it, but the fading light precluded further accurate observations. The fledgling remained close by this nest for a short while, then it moved higher up into the top of the tree, where it remained alone overnight.

The following unique observations were made by the author's assistants, Kibore Chepkonwe and Samson Sungula. During October and November 1980 two pairs were nesting at the same time in a Fig, but at different stages. Two fledglings of one pair were moving about in the Fig and, while they were unattended, were seen to move into the nest where one of the other pair was incubating. When their real parent returned, they moved out of this second nest to be fed. On another occasion, a fledgling returned to a Fig from valley A, joined the two fledglings of another pair, and they were fed by their respective parents. The three fledglings then spent that night in the Fig.

Jarvis & Currie (1979) mention that one Knysna Lourie pair which had successfully raised

three chicks showed no animosity towards them while incubating, having relaid again when the chicks were 40 days old. These chicks frequently sat next to the parents as they incubated.

TABLE 8
Development of juveniles

Age in Days	
1	Covered in dark brown neossoptile down. Eyes slightly open, beak pale with dark tip.
4	Eyes open.
10	Pull at leaves near nest. Wings approximately 70 mm, tails 25 mm, both with visible quills.
12-14	Beaks dark all over, except for near base and pale line under eye (extension of gape).
17-18	Increasingly energetic, fluttering around in nest, seen at nest edge.
20	Wing size large in comparison to head and tail, brown eyes.
21	Preens. Anus still billed by parent and excreta consumed by parent.
24-25	Beginning of grooving in beaks, which are still dark except the base and pale line under eye, visual estimate of beak length 35 mm.
26	Wing growth accelerated, body large in proportion to nest size. Wings and tail have adult colouring.
27-29	Activity outside and above nest. First seen alone at 27 days.
31-38	Leaves nest.
34	Head flat. Beak of one nestling had definite groove at this stage.
40-45	No crest development. One fledgling had estimated age of 40-45 (hatching date unknown). Had 4 tail feathers all 229 mm in length (one tail feather had 50 mm of cream marking), rust feathers on thighs. 19 primaries + 1 very small, 24 secondaries, 7 pectoral tuft. Blue tuft on bump below eye. Longest toe 63 mm.
45-60	No observations.
66*	Considerable change. Five crest feathers, wide cream band in tail, tail growth accelerated. Eyes brown, beak dark.
73	Beak becoming paler.
78	Sub-adult, crest growth, beak yellower with red tip.
86	Calls like adults. Still being fed by parents.

* It must be stressed that the ages in days from 66-86 are very tentative and approximate.

TABLE 9
Breeding success 1976 - 1981

Number of pairs	21
Breeding attempts	18
Number of eggs hatched	14
Number of nestlings	14 - 1 (which fell from nest)
Number of fledglings	13 - 2 (disappeared from tree)
Total	11

Percentage of successful fledglings 78%

POINTS REQUIRING FURTHER STUDY

1. No bird, during the study, was seen to drink water. However, Hartlaub's Turaco has been seen to do so at bird tables in Nairobi (Van Someren 1956). Stannard (1971) never saw the Knysna Lourie drink at a birdbath, but once saw one come down and drink from a small pool on a stone step. Eating of insects was not observed, nor wild plantain seeds, and the description of some turacos as plantain eaters may thus be erroneous.

2. More information is required before any definite link can be established between the onset of building and the flowering of certain tree species. For example, in July and August large numbers of *Cordia abyssinica* trees are in full bloom, and, at this time, there is an upsurge in nesting activity.

3. The presence of a third bird in the vicinity of a nesting pair raises questions as to its identity, whether as a helper or as a previous offspring. Colour ringing of individual birds would be effective for any further study, and would aid information as to how long fledglings remain with parents and at what age they achieve adult plumage. Colour ringing might also help to establish whether communal feeding takes place.

4. Without individual identification it is difficult to ascertain the exact progress of fledglings in the wild. It is thought that after leaving the immediate nesting area the fledglings remain in the natural forest areas and are fed for as long as three months by the parents (and possibly longer). During this time they develop stronger flying ability, gradually undertaking longer distances (e.g. the 200 m stretch across two tea sections). It is surmised that they remain with the family for a considerable time before joining up with a group. The beak of a fledgling develops more slowly than the crest and would appear to be the last part to develop adult colouring.

5. There is possibly some sexual dimorphism in the beak, that of the male being possibly shorter, thicker and more grooved.

6. It is open to discussion whether the Blues mate for life. It is possible that they pair off to breed and remain together long enough to raise the young to maturity, and then re-join the group. However, whether this bond remains within a group is not known. Here again colour ringing would be useful.

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